12.0 REGULATORY IMPACT

Fuel tank inerting systems affect regulations embracing type certification, airplane operations, maintenance operations, and (possibly) airport facilities. This section addresses the impact on the regulations of these areas.

12.1 TYPE CERTIFICATION

14 CFR Part 25

The certification of a fuel tank inerting system would involve two aviation regulations:

- *Flammability Rule*—sets flammability exposure standards for which an inerting system may be designed to reach compliance.
- *Inerting System Rule*—governs the design of inerting systems.

Flammability Rule

The purpose of the Flammability Rule is to regulate the allowable flammability level of the fuel tank ullage.

Because the FTIHWG has determined that all fuel tank inerting systems are impracticable in accordance with the FAA regulatory evaluation requirements, new regulatory content cannot be recommended for a Flammability Rule. Therefore, no change is recommended to the text of the current Flammability Rule (14 CFR §25.981(c), introduced by FAR Amendment 25-102, effective June 6, 2001) to establish a new acceptable minimum flammability level that is equivalent to that which could be achieved by an inerting system design concept.

This decision is based on the overall work of the FTIHWG, which used the following ground rules established by the FAA Tasking Statement:

- "Flammability" is defined as the susceptibility of the fuel/air vapor (ullage) present in a fuel tank to readily ignite or to explode.
- For the proposed regulatory text, fuel tank inerting could be an acceptable method of compliance.
- Flammability is to be treated independently from fuel tank ignition prevention.
- A performance-based definition provides the applicant with a set of design requirements, not a prescriptive design requirement.
- Flammability reduction only through fuel tank inerting was to be considered by the FTIHWG, which was asked not to address or consider other methods for controlling the flammability of fuel tank ullage.

The pros and cons of five different regulatory text proposals were evaluated against the 13 fuel-tank-inerting design proposals. No improvements to the current regulatory text could be found because the current text clearly states that *in the context of this rule, 'minimize' means to incorporate practicable design methods to reduce the likelihood of flammable vapors*. This wording allowed current applicants to comply with the Flammability Rule without being required to incorporate an inerting system, which the FTIHWG determined not to be practicable.

The team decided to discard the other options (discussed in app. I) because they were

- Not practical to impose a numerical limitation because of the lack of an industry-agreed pass/fail criteria (option A).

- Too shortsighted to limit the rule to a flight phase considering that the "risk" may occur in a flight phase other than ground (option B).
- Too restrictive for inerting and the Tasking Statement because the primary means of compliance would be through heat control (option C).
- Linked to ignition source control and, therefore, outside the scope of the Tasking Statement. Not practical to impose a numerical limitation because of the lack of an industry-agreed pass/fail criteria (option D).

Flammability Assessment—Guidance Material

Because of the adverse results of the cost-benefit evaluation performed by the FTIHWG, we recommend not to set a flammability design objective that is achievable only with an inerting system.

We therefore recommend that, if possible, the FAA formulate with industry experts a flammability evaluation method and follow-on flammability standard that meet the FAA regulatory evaluation requirements.

Inerting System Rule

Although the FTIHWG determined that fuel tank inerting systems were not practicable, the existing Flammability Rule, 14 CFR §25.981(c), does not preclude an applicant from voluntarily fitting an inerting system on its airplane.

If an inerting system is fitted, the Rulemaking Task Team determined that certain design features should be regulated within the inerting system design. This control can be done either by means of a special condition or by a change to 14 CFR Part 25.

This determination was made following a certification-compliance evaluation of the proposed ground-based and onboard inerting designs. The evaluation considered the inerting system's safety, design (including installation requirements), and operational performance requirements.

This review process identified a total of

- Three insufficiencies in 14 CFR 1-1-00 Edition (current regulation could be slightly modified to address the specifics of the inerting design).
- Thirty-six applicable paragraphs in 14 CFR 1-1-00 Edition, but not requiring regulatory text modifications.
- Three new concerns unique to inerting systems.

Because of the number of considerations that must be regulated within a fuel system inerting design, the team recommends that a dedicated 14 CFR Part 25 paragraph titled "Fuel Tank Inerting System" be adopted if inerting systems are to be installed on transport category airplanes. This paragraph should be worded in such a way that it can apply to both ground-based and onboard inerting systems. A proposed wording is provided later in this section.

Inerting System—Guidance Material

If inerting systems are to be considered as aviation equipment, guidance material needs to be prepared and published. This guidance material should be consistent with the inerting technology under certification.

14 CFR Part 21

14 CFR Part 21 provides airplane certification procedure for products and parts. It was reviewed to determine if any current certification procedures would need to be changed if inerting systems were implemented on transport category airplanes.

The FTIHWG concluded that there is no impact on the current regulations versus type certification or modification activities.

The team also concluded that 14 CFR Part 21 is affected if the FAA were to initiate a retroactive rule action. The retroactive rule action would require a change to 14 CFR Part 21, which is the SFAR section. The SFAR regulatory action would need to state the airplane applicability and the required compliance, including the task accomplishment statement and FAR 25 rule references, the time frame for compliance, and the reference to any maintenance or inspection activities.

12.2 MAINTENANCE AND AIRPLANE OPERATIONS

The Rulemaking Task Team identified and assessed the following 14 CFR sections that relate to airplane maintenance and operations, considering that either a ground-based or onboard inerting system was installed in the airplane:

- Part 43, Maintenance, Preventative Maintenance, Rebuilding, and Alteration.
- Part 91, General Operating and Flight Rules.
- Part 121, Operating Requirements: domestic, flag, and supplemental operations.
- Part 125, Certification and Operations: airplanes having a seating capacity of 20 or more passengers or a maximum payload capacity of 6,000 or more.
- Part 129, Operations: foreign air carriers and foreign operators of U.S.–registered airplanes engaged in common carriage.

The Part 43 assessment was carried out independently.

The other parts were assessed using Part 121. That is, the team assumed that any change applicable to Part 121 could be read over to Parts 91, 125, and 129. This assumption was made based on the FAA's ignition source prevention activity (NPRM 99-18/SFAR no. 88, effective June 6, 2001).

The team did not consider Part 135 operating requirements, which cover commuter and on-demand operations. The Rulemaking Task Team decided that the FAA could adapt the recommendations made for 14 CFR Parts 91, 121, 125, and 129 to other similar 14 CFR sections.

The Rulemaking Task Team also assessed the impact on retroactive rulemaking.

Maintenance and Airplane Operational Regulations

14 CFR Part 43. The Rulemaking Task Team determined that, if a fuel tank inerting system were installed on an airplane, the 14 CFR Part 43 standards did not need to be modified. Today's standards can adequately accommodate an inerting system.

14 CFR Parts 91, 121, 125, and 129. The Rulemaking Task Team determined that the type of inerting design and the final decisions by the designers, airlines, and operators would greatly influence the types of changes needed for 14 CFR operational sections.

The following conclusions are provided:

General Conclusions. The Rulemaking Task Team recognized that the regulatory impact of the operational sections of 14 CFR sections may go well beyond the conclusions made within this report.

The group acknowledged that, if inerting systems were incorporated, considerations on how to grant MMEL relief in accordance with prescribed FAA procedures need to be further studied. The number of potential installations, the complexity of these installations, and the method by which they are introduced all influence allowed MMEL.

Regulatory Impact on All Fuel Tank Inerting Systems. Three specific concerns that affect the regulations and apply to all inerting systems were identified:

- The requirement to have an approved operational and maintenance program.
- Assurance that NEA (oxygen-depleted air) cannot physically harm passengers and crew.
- Statement of when and under what conditions an airplane may need a fuel tank inerting system.

Approved Operational and Maintenance Program. The team recommends that the regulatory change be presented in a new 14 CFR 121 (or equivalent) paragraph in a manner similar to §121.629, Operation in Icing Conditions. In this way, all the information can be found in one place and not dispersed between a variety of paragraphs. A proposed wording is offered later in this section.

NEA's Physiological Effects. Because nitrogen-enriched or oxygen-depleted air can physically harm passengers and crew in confined spaces without adequate ventilation, we propose that §121.229(c), Location of Fuel Tanks, be amended to state that nitrogen gas should be isolated from personnel compartments. The isolation should be shown for nitrogen gas present in both the fuel tanks and the inerting system equipment (pipes, valve, and so on).

Conditions Under Which a Fuel Tank Inerting System Is Installed. If the FAA decides to mandate fuel tank inerting systems, then the perceived role of this system should be stated within 14 CFR Part 121 (or equivalent).

The team recommends creating a new §121.300 paragraph to state when and under what conditions airplanes may need a fuel tank inerting system. This may be accomplished by a sentence stating that a fuel tank inerting system may be installed on an airplane as a means of meeting the requirements of §25.xxx of the chapter in effect on a given date.

An alternative recommendation is to modify §121.316, Fuel Tanks, using the same wording.

Ground-Based Inerting Systems. For GBIS, five additional regulatory paragraphs need to be created or modified. We have identified the concept of what these paragraphs should contain. Specific regulatory changes should be reviewed with the operational specialists using a design concept for in-service use.

The Rulemaking Task Team's conclusions on these impacts were based on three facts:

- Ground-based inerting is a specific action that requires a specific, independent procedure.
- Ground-based inerting cannot be accomplished without the complementary airport facilities.
- The operational program will be developed using procedures inherent to the ground-based inerting design concept.

Because ground-based inerting systems are not self-contained aboard the airplane and thus require interface with the airport and ground personnel, the team recommends that the new fuel tank regulatory paragraph make references to other applicable paragraphs within 14 CFR.

The team proposes that five additional 14 CFR 121 paragraphs be modified (or concepts be included within the new fuel tank inerting paragraph):

- §121.97, Airports: Required Data—add nitrogen supply capability under (b)(1), Airports.
- §121.105, Servicing and Maintenance Facilities—include nitrogen supply capability in equipment example.
- §121.117, Airports: Required Data—add nitrogen supply capability under (b)(1), Airports.
- §121.123, Servicing Maintenance Facilities—include nitrogen supply capability in equipment example.
- 121.135(b)(8), Contents, information contained in the manual—add new equipment, (b)(25), concerning inerting facilities or modify (b)(18) to add inerting to the refueling procedures.

Onboard Inerting Systems

OBIGGS. For onboard inerting systems, we anticipate no impact on the operational regulatory sections; no additional paragraphs were identified for creation or modification.

If pressure-vessel air is used for inerting, regulatory changes may need to be implemented somewhere in the 14 CFR code to ensure that cabin air pressure is maintained as the airplane ages or if it is dispatched on MMEL relief with an inoperative pack.

Onboard hybrid systems may require the regulatory modifications as described under ground-based inerting, recognizing that the airport facility requirements would be different (onboard ground electrical source requirement; ground-based inerting nitrogen supply requirement). Specific regulatory changes should be reviewed with the operational specialists using a design concept proposed for in-service use.

The Rulemaking Task Team's conclusion was based on three facts:

- Onboard inerting is a system integral to the airplane; airport facilities are not needed.
- The activation of the onboard system would be done on the airplane (automatically or manually).
- The team determined that the operational program would be developed using procedures inherent to the onboard inerting design concept.

OBGI. If an onboard ground system is developed, both ground-based inerting recommendations should be considered, recognizing that the airport facility requirements would be different (onboard ground electrical source requirement; ground-based inerting nitrogen supply requirement).

Impact on 14 CFR Part 121 (or equivalent) Subparts L, N, and T. Given the amount of knowledge that the Rulemaking Task Team had on the inerting systems and their impact on airplane operations, it concluded that there was no impact on Subparts L, N, and T. The current wording is sufficient to ensure proper training on inerting systems. Modifications or new paragraphs may need to be introduced once an inerting system is actually proposed for in-service use.

Retroactive Rule Action. A retroactive rule would be initiated by FAA decision and by a simultaneous change to 14 CFR Parts 21 and 121 (or equivalent). The retroactive rule needs to be closely coordinated within both the FAA's certification and airworthiness standard branch and the Aircraft Evaluation Group. The FAA needs to consider carefully any retroactive rule action against its impact on the MMEL or MEL.

FAR 121.300 will have to be updated to be in line with the SFAR (FAR 21) rule change. The new 121 rule will have to contain provisions concerning time required to introduce the new rule, airplanes affected, operational requirements, and any grandfather clauses (especially if there is a time factor linked to equipping domestic and foreign airports).

Operational Guidance Material

An operator will need to have an approved inerting maintenance and operational program. This program is very important because there is a risk of death if nitrogen is not handled properly. Guidance material should be issued to that effect before any inerting system is operated.

Considering that no commercial aviation operation has ever operated or maintained a fuel tank inerting system, the guidance material should be updated on a regular basis until the subject becomes mature.

12.3 AIRPORT FACILITIES

The Rulemaking Task Team assessed 14 CFR Part 139 as to whether the standards for certification and operation of airports serving certain carriers would be affected by fuel tank inerting systems.

The team determined that one change to 14 CFR Part 139 standards would be needed if ground-based inerting were implemented.

The regulatory change could be justified in one of two ways: (1) regulate the safety of the public and airport when handling nitrogen and (2) regulate the hazard of the airplane and state that the airport must ensure that this hazard does not exist. The proposed regulatory text composition is found in the regulatory text section 12.5.2.

No changes to 14 CFR Part 139 have been identified if onboard inerting were to be implemented.

12.4 ENVIRONMENTAL

There is currently no regulatory impact identified from the increase in the amount of VOCs vented from the fuel tank as a result of inerting.

It was determined that 14 CFR Part 34, Fuel Venting and Exhaust Emission Requirements for Turbine Engine Powered Airplanes, would not be affected because these regulations concern the intentional discharge of liquid fuel to the atmosphere that is drained from the nozzle manifold after the airplane gas turbine engines are shut down.

12.5 REGULATORY TEXT AND GUIDANCE MATERIAL

The FAA Tasking Statement requested that the FTIHWG do the following:

- Review existing regulations, advisory material, and continued airworthiness instructions concerning the elimination or reduction of the flammable environment in the airplane fuel tank system.
- Prepare regulatory text for new rulemaking by the FAA to eliminate or significantly reduce the flammable environment in airplane fuel tank systems.
- Develop and propose guidance material for all recommended system concepts that describes the necessary analysis, testing, or both that may be required to show compliance with the new regulatory text for certification and continuing airworthiness.

The Tasking Statement further requested that the FTIHWG propose recommendations based on achieving the lowest flammability level that can be provided by an inerting system design that would meet FAA regulatory evaluation requirements.

In this section, we summarize the regulatory assessment method, provide specific regulatory text recommendations, and present an overview of potential guidance material that is associated with the regulatory text proposals.

12.5.1 Methodology

This section describes the method adopted by the Rulemaking Task Team to meet the requirements stated above.

Basic Assumptions

The Rulemaking Task Team assumed that both the ground-based and onboard inerting designs would be certified and used. This broad assumption was made because the absolute and relative practicality of these individual design approaches was not known.

Determination of 14 CFR Sections to Be Evaluated

The team examined the airplanes used to determine which sections of 14 CFR might be affected by the two inerting designs. The team confirmed that, at a minimum, airplane certification, maintenance, operational approval, and airport facilities would be affected. The team concluded that an assessment of the major issues affecting 14 CFR could easily be transferred to a Joint Aviation Requirements assessment if final rulemaking were pursued.

Analyses of the Regulatory Impact on the Existing Codes

The Rulemaking Task Team then used the design concepts developed by the other FTIHWG task teams to analyze the impact on the existing regulations, advisory material, and continued airworthiness instructions. This analysis was performed throughout the FTIHWG process to ensure that all design issues were accounted for in the final 14 CFR change recommendations.

Development of Guidance Material

The team developed guidance material to support the 14 CFR change proposals.

Flammability Regulatory Text Proposals

Finally, regulatory text was proposed within the FTIHWG that could be used by the FAA to regulate an airplane's fuel tank environment to the level of flammability reduction achieved by a practicable inerting system design concept. The Rulemaking Task Team highlighted the pros and cons of each proposal, including its possible certification interpretations and its capability to allow an inerting system as an acceptable means of compliance.

Certification Cost Assessment

The Rulemaking Task Team calculated a certification cost estimate for both ground-based and onboard inerting systems. These costs were inputted into the overall cost-benefit study.

HWG Flammability Regulatory Text Recommendation

The FTIHWG was tasked with determining which proposal, if any, to recommend. This recommendation would be based on the outcome of the regulatory evaluation for new rulemaking as required by the Tasking Statement.

12.5.2 Regulatory Text

Flammability Regulatory Text Proposal

No new regulatory text is proposed because there are no inerting systems that are practicable. Therefore, a minimum allowable flammability level based on an inerting design concept cannot be incorporated into a regulatory text.

Inerting System Regulatory Text Proposal

An applicant who decides to incorporate an inerting system should include a minimum number of design precautions for the system. The regulatory text proposal in this section provides words that address the concerns identified within the certification compliance evaluation. This text can be used either as a special condition or be added as a new paragraph to 14 CFR Part 25.

§25.xxx Fuel Tank Inerting System
If, in order to show compliance with §25.981(c), a fuel tank inerting system is installed,
(a) the fuel tank inerting system must not, under normal and failure conditions:

(i) allow any inerting agent leakage into the pressurized or personnel compartments, or confined spaces; and
(ii) allow overpressure of the fuel system.

(b) The fuel tank inerting system must have:
(i) A connecting port such that a cross-connection with any other supply line is not possible (applicable if supplied by an external inerting gas source).
(ii) At each inerting agent filler opening and each airplane opening leading to direct contact with the inert gas, a placard at or near the filler cover or opening with the words "Fuel tank inerting" and the agent denomination.
(iii) A means to prevent the escape of hazardous quantities of fuel from the system in the case of loss of system supply pressure.
(iv) A shutoff or isolation means, whose failure to function is evident, that prevents undesirable system functioning and possible fuel leakage.
(v) A tolerance to variable inerting gas pressures or surges in the gas delivery system.

(c) Cautions (placards) and warnings (indication system) should be provided to prevent unintentional entry into a confined space filled with a hazardous inert gas.
(d) The characteristics and designation of the inert gas that ensure correct operation of the fuel tank inerting system shall be recorded in the operating limitations section of the Aircraft Flight Manual or equivalent.

Maintenance and Airplane Operational Regulatory Text

If an inerting system is installed on an airplane, then a new 14 CFR 121 (or equivalent) paragraph should be introduced in a manner similar to §121.629, Operation in Icing Conditions. In this way, all the information can be found in one place and not dispersed between a variety of paragraphs.

The fuel tank inerting paragraph should include the following topics and include or refer to specific concerns that are only relevant to ground-based inerting operations or onboard inerting operations.

§121.xxxx (or equivalent) Operation of Fuel Tank Inerting System.
(a) A section providing a statement of the dispatch or release condition of an airplane containing a fuel tank inerting system.
(b) A section providing a requirement for an approved fuel tank inerting program including details of:
(i) How the certificate holder determines that he or she needs to inert the airplane fuel tanks.
(ii) Who is responsible for this decision.
(iii) The procedures for implementing this decision.
(iv) The specific duties and responsibilities of each operational position.
(v) Define confined space procedure for the inerting system.
(vi) Initial and annual recurrent ground training and testing for all affected personnel that addresses the:

- *Identification of system limitations (e.g., minimum time to inert on landing or before takeoff).*
- *Creation of communication procedures.*
- *Identification of flight crew's role at dispatch and at landing.*
- *Identification of the nitrogen's specifications and characteristics.*
- *General conditions under which the more specific requirements are alleviated.*

More specific regulatory text wording was not developed because it was undetermined at the time of the evaluation which if any of the inerting systems would be practicable.

Airport Facilities Regulatory Text

If ground-based inerting were to be implemented, then a regulatory text change to 14 CFR Part 139 would be recommended to ensure that the services are available to carry out ground-based inerting.

The regulation should address

- The availability of nitrogen gas.
- Facility, procedures, and personnel training standards.
- Infrastructure to ensure that airplanes are inerted within a minimum time before their next scheduled departures.

More specific wording was not developed because of the immaturity and impracticality of ground-based inerting.

Environmental Regulatory Text

There are no regulatory text proposals associated with addressing environmental concerns because no regulatory impact has been identified.

12.5.3 Intent of Proposed Guidance Material

The Rulemaking Task Team developed guidance material to support the regulatory text recommendations.

The Rulemaking Task Team defined a working methodology, developed the foundation of a guidance material proposal using the work developed within the FTIHWG, and formed recommendations for further improvements.

Methodology Used to Develop the Inerting System Guidance Material

The regulatory text change review identified four core subjects:

- Retroactive rule, SFAR (14 CFR Parts 21 and 121).
- Design and certification (14 CFR Parts 25 and 34).
- Operation and maintenance (14 CFR Parts 43, 91, 121, 125, and 129).
- Airport facilities (14 CFR Part 139).

The Rulemaking Task Team developed guidance material for two of the four subjects:

- Design and certification (14 CFR Parts 25 and 34), further split into two topics:
  - Flammability Rule guidance material.
  - Inerting System Rule guidance material.
- Operation and maintenance (14 CFR Parts 43, 91, 121, 125, and 129) as applicable to the use of an inerting system.

The team determined that the retroactive rule did not need associated guidance material by nature and that issues surrounding airport infrastructure were too immature to develop effectively.

Flammability Rule Guidance Material

The Rulemaking Task Team agreed that the flammability regulatory text (or the existing FAA flammability recommendation, where a flammability regulatory text could not be recommended) should be associated with some guidance material.

The purpose of the guidance material should be to define the "standard" by which the applicant's product is going to be evaluated and judged acceptable. It should be used to identify the design, the procedures, or both that are needed to ensure the safety of the airplane design. The guidance material should not identify how to design a system. For example, the guidance material associated with this rule should not provide advice to an applicant on how to design and operate a fuel tank inerting system.

The standard should be subdivided into four subtopics:

- The circumstances for conducting an assessment of flammability.
- The decision to pursue regulatory text evaluation.
- The assessment of the flammability—the state under which the product needs to be placed to obtain the parameters needed to make a judgment on performance (i.e., the "playing field" and "rules of the game").
- The standard itself—the basis on which the compliance decision will be based (determination of compliance).

The team agreed that an acceptable performance-based rule is one in which the regulatory text and the standard are compatible and ensure an equivalent safety level across all product lines.

Development of the Standard as Limited by the Tasking Statement. The Tasking Statement limited the team's ability to develop a flammability standard. The Tasking Statement required the team to determine whether fuel tank inerting could be used as the practicable industry standard to show compliance with a flammability regulatory text. The FAA considered that subtopics a through c were addressed by FAA AC 25.981-2.

Development of a Standard Excluding the Tasking Statement Instructions. Some team members felt that if the FTIHWG were to endorse or create a flammability regulatory text, then all subtopics within the standard's definition should be addressed irrespective of the Tasking Statement.

The team decided to discuss each subtopic and document its general concerns. These concerns could then be expanded as appropriate to the regulatory text development.

Circumstances for Conducting an Assessment of Flammability. AC 25.981-2 provides guidance in this area. However, some team members felt that a flammability rule should not be applied to fuel tank ullage if all the mechanical and electrical potential ignition sources were removed.

This determination could be made by developing a qualitative pass/fail criterion; no credit is given for probability of failure. The design either complies with the condition (i.e., " pass") or it does not (i.e., "fail"). If the applicant passes the checklist, then the flammability regulatory text is not applicable.

Decision to Pursue Regulatory Text Evaluation. The team agreed that the purpose of the flammability regulatory text needed to be clearly stated within the guidance material.

The airplane design goal (airplane safety objective) needs to be stated. Any performance-based words (e.g., "minimize" or "limit") need to be defined. The goal can be defined as specific (e.g., X% flammability exposure) or can be defined by a design assessment associated with a pass/fail criterion.

Some team members felt that the guidance material should give credit for mitigation of ignition sources by either of two means:

- Protection of the fuel tank from structural and systems damage in the event of an ignition of the tank's fuel/vapor air mixture.
- Snubbing of the spark before it comes in contact with the flammable fuel/air vapor mixture so that ignition does not occur.

In the first of the above approaches, an example of an acceptable means is the use of appropriate foam. The fuel tank is filled with a type of foam that ensures the control of the pressure rise following ignition of the fuel/air vapor mixture.

Assessment of the Flammability. AC 25.981-2 provides a method to determine the average flammability exposure of a given tank.

Some team members raised concerns over whether an average flammability exposure calculation really provides the correct type of assessment needed to prevent the "accident risk."

The team estimated that at least seven parameters needed to be assessed to determine whether in fact the accident risk has been mitigated:

- *Influence of outside ambient air temperature.* ISA/ISA +73.4°F variation can be used to determine operational limitations and measure the effectiveness of any design or operational changes based on outside conditions.
- *Effect of fuel loading on the fuel tank heat transfer characteristics*. The results can be used to show the thermodynamic influence of fuel on the overall ullage cooling behavior and resultant flammability exposure.
- *Thermodynamic characteristics of each piece of equipment or each system.* The results can be used to identify the contribution of each piece of equipment or each system to the overall ullage characteristics. This in turn can be used to identify design changes or operational constraints (e.g., MMEL or ground operation procedures).
- *Influence of ground operation time*. The results can be used to understand the influence of ground operation on the fuel tank ullage temperature. The results can be used to substantiate design decisions or operational procedures.
- *Identification of hot spots*. The results can identify whether there is a local change in the flammability characteristics of the ullage.
- *Differences or similarities between the tanks*. The results can identify whether any tank has an unusual thermodynamic characteristic as compared to the others. The reason for this difference can be evaluated and then used to determine whether any design or operational actions need to be taken.
- *Identification of the degree to which a design is influenced by natural physical properties versus by design choices*. The results can be used to establish a comparison basis with ambient conditions. The results from the unheated configuration show the flammability exposure characteristic of the design based only on fuel loading, pressure, and aerodynamic effects. The results from the heated configuration show the influence of the internal fuel system mechanical components and the adjacent systems on the flammability exposure. The comparison of heated and unheated results can be used to show the direct benefit on flammability exposure of any design or operational changes under a certain fuel loading and outside ambient air condition.

Team members agreed that probably both the average risk and specific risk were needed to ensure that all hazards were addressed within the design.

Determination of Compliance. Team members voiced concerns over use of subjective, imprecise words and phrases such as “minimize” or “limit the development.”

Experience has shown that differing opinions between the applicant and regulatory authority as to what constitutes “minimize” or “limit” has led to costly delays in some certification programs.

Industry team members encouraged the FAA and the JAA to work with them as an industry group to develop a process and associated numerical conditions by which the word “applicable” can be judged. An example of a process is a flowchart that provides acceptable design conditions and choices about how to proceed depending on conditions. An example of a numerical condition is an average flammability exposure percentage or a temperature limit.

Inerting System Rule Guidance Material

The guidance material was created using the fuel tank inerting systems design proposals of two FTIHWG design teams and the regulatory evaluation assessment.

The team recommends, however, that this guidance material be refined using real fuel tank inerting design concepts that are proposed for in-service airplanes.

The objective of the guidance material is to provide information and guidance on the design, installation, and certification of an NEA inerting system. It can then be used, if desired, to create an FAA AC pertaining to fuel tank inerting systems.

The team assumed that the applicant chose to install an NEA inerting system on one or all of its airplane's fuel tanks. The design objective of the inerting system is to reduce or eliminate the flammable environment created in the fuel tanks' fuel/air vapor ullage (the means by which to show compliance to FAR/JAR 25.xxx).

The team took for granted that this guidance material would not become mandatory and would not constitute a regulation. Its purpose is to provide the applicant with advice and a method of compliance that has been found acceptable to the FAA and the JAA (certifying authorities).

Maintenance and Airplane Operations Guidance Material

The guidance material was created using the fuel tank inerting systems design proposals of two FTIHWG design teams, the regulatory evaluation assessment, and guidance material written on systems that interface with airport facilities or systems that are implemented because of environmental concerns.

The team recommends that this guidance material be refined using real fuel tank inerting design concepts that are proposed for in-service airplanes.

The objective of the guidance material is to provide

- Information and guidance on the operation and maintenance of an NEA inerting system.
- Guidance in obtaining approval for a fuel tank inerting program.

This material may be used, if desired, to create an AC pertaining to fuel tank inerting systems.

The team assumed that the airplane had a fuel tank inerting system (ground or onboard) installed and that the applicant (AC user) is an operator seeking to gain approval of its fuel tank inerting maintenance and operation program.

The team took for granted that this guidance material would not become mandatory and would not constitute a regulation. Its purpose is to provide the applicant with advice and a method of compliance that has been found acceptable to the FAA and the JAA (certifying authorities).

12.5.4 Guidance Material

Guidance material was developed for

- Fuel tank inerting system—design, installation, and certification.
- Fuel tank inerting system—operation and maintenance.

This section provides a general overview of the contents of each guidance material evaluation.

Fuel Tank Inerting System—Design, Installation, and Certification

The detailed guidance material proposal is found in appendix I, attachment 1. It complements the guidance material already published in AC 25.981-2. That AC describes the general concept of an inerting system, whereas this proposal discusses not only the general concept but specific design considerations as well.

This guidance material provides an overview and background details about its purpose, background, related documents, and definitions and abbreviations.

The guidance material then discusses the general concept of fuel tank inerting and explains the fundamental principles behind the different fuel tank inerting design concepts (based on the FTIHWG's design concept studies). This section further provides an applicant with information concerning the flight phases for which the design is most likely effective, the general impact on the airplane design and operation (system criteria and operational impact, including airport facilities interface), and specific information concerning dedicated inerting system equipment.

Also discussed are specific concerns relating to

- System installation considerations.
- Airplane interfaces.
- Certification plan and compliance demonstration.
- Continued airworthiness and maintenance considerations.
- Nitrogen precautions.
- Environmental impact.
- MMEL assessment.

If inerting systems are installed on airplanes, the team recommends that either AC 25.981-2 be expanded to include fuel tank inerting design considerations, or that a dedicated AC titled "Fuel Tank Inerting Design and Certification" be created.

It is recommended that any AC be again reviewed using an actual certified inerting design because the design considerations recommended in this guidance material are based on hypothetical designs. The lessons learned during an actual design project may assist others in designing and certifying airplanes.

Fuel Tank Inerting System—Operation and Maintenance

The detailed guidance material proposal is found in appendix I, attachment 2. There are no other known recommended guidance material or ACs existing in the public domain.

The guidance material provides an overview and background details about its purpose, background, related documents, and definitions and abbreviations. This material then states that all fuel tank inerting operation and maintenance programs will contain six parts:

- Management plan.
- Dispatch conditions, including any timetables.
- Operations manual—inerting operational procedures.
- Maintenance program—maintenance manual.
- Training.
- Health and safety standards.

Note that local airport emission requirements may have to be evaluated against the possible excess of fuel tank emissions resulting from inerting (these emission effects will be design and airplane dependent).

Next, the guidance material explains the specifics of each of the above six parts.

Management Plan. The management plan is a detailed description of the operational responsibilities and procedures associated with the implementation and conduct of the certificate holder's "fuel tank inerting program." The management plan may differ depending on the type of inerting system.

The purpose of the management plan is to ensure operational control over the execution of a fuel tank inerting program.

Dispatch Conditions, Including Any Timetables. Certain design features of airplanes (e.g., their fuel tank vent system) and fuel tank inerting system may impose certain usage conditions or limitations. These conditions and limitations may be related to time, outside ambient temperatures, flight phase, fuel tank loading, or a set of multiple conditions.

If limitations exist, then the certificate holder's program should define operational responsibilities and develop procedures to instruct the flight crews, airplane dispatchers, flight followers, and maintenance and ground personnel on the condition limitations, evaluation of these limitations, and resultant actions to be taken.

Operations Manual—Inerting Operational Procedures. Operational procedures associated with the fuel tank inerting system installed on the airplane type should be approved as part of an operator's initial operational manual approval or as a revision to that manual, the Airport Handling Manual, or the MEL.

A quality assurance program should be established in accordance with the management plan and applicable 14 CFR regulations.

The MEL should be developed based on the manufacturer's recommendations and the operator's operational policies and national operational requirements.

Maintenance Program—Maintenance Manual. Maintenance procedures for the fuel tank inerting system installed on the airplane type should be approved as part of an operator's initial maintenance manual approval or as a revision to that manual.

For ground-based inerting, the characteristics and specification of the nitrogen that will be used to inert the fuel tanks should be defined and recorded in the appropriate manuals.

For onboard inerting, particular attention should be paid to the efficiency (service life) of the ASM (which provides nitrogen), noting that NEA will not be produced if this component does not perform its intended function.

Training. Initial and recurrent ground training and testing for all affected personnel (e.g., airplane dispatchers, ground crews, contract personnel, and flight crew) need to be conducted.

A quality assurance program should be established in accordance with the management plan and applicable 14 CFR regulations.

Health and Safety Standards. The operator's health and safety standards should be updated to include working with nitrogen.

If inerting systems are installed on airplanes, the team recommends that this guidance material be used to issue an AC titled "Fuel Tank Inerting Operational Program Approval."

It is recommended that any AC be again reviewed using an actual operation and a maintenance program developed for using a certified fuel tank inerting system. The lessons learned during the implementation of the operation and maintenance program may assist others in any future implementation exercise.

Other Potential Regulatory Impact

Fuel tank inerting systems implemented on a large scale may increase VOCs vented from fuel tanks as their fuel/air vapors are displaced by the inerting process. However, environmental regulations are outside the scope of FAA jurisdiction and the scope of this task.

13.0
Conclusions & Recommendations